MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EMG4116 – IMAGING RADAR SYSTEMS

(TE)

18 OCTOBER 2018
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 3 Questions only.

2. The student is required to answer all questions. Each question carries a particular marks and the distribution of the marks is given .

3. Please write all your answers in the Answer Booklet provided .

Question 1

(a) With aid of a diagram, discuss the basic operation of an imaging radar system. The diagram must consist of the basic module of imaging radar system.

[8+8 marks]

(b) Describe two advantages and two disadvantages of using Synthetic Aperture Radar.

[4+4 marks]

(c) You are designing an antenna for a Side Looking Radar (SLR) system using real aperture technique. If you use a 5 cm wavelength, what antenna length would be required to have an azimuth resolution of 1 m at a ground range of 5 km? Comment on the practicality of the antenna length.

[8 marks]

(d) If SAR system is used in (c), what is the theoretical antenna length to achieve the same azimuth resolution in (c)?

[4 marks]

Continued .....

Question 2

a) Describe the advantages and disadvantages of the Range-Doppler algorithm (RDA).
[3+3 marks]

b) Define what is meant by SAR interferometry, giving one example applications of it in practice.
[6 marks]

c) Based on Geometry of Interferometry SAR shows in Figure Q2, show that δR can be expressed as $\delta R = \frac{\lambda\phi}{4\pi}$ (You may use either single pass or repeat pass SAR)

where λ is the wavelength and ϕ is the interferometric phase.
(Assuming Antenna 1 will generate image of E1 and Antenna 2 will generate image of E2)
[12 marks]

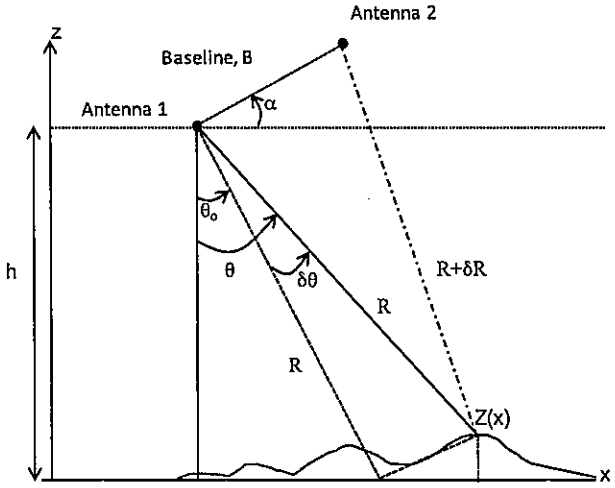

Figure Q2

d) What is the difference between repeat-pass and single-pass SAR interferometry (InSAR)? Which is the most suitable for measuring land surface topography (height mapping)?
[6 marks]

Continued .....

Question 3

(a) Figure Q3 shows the block diagram of an airborne synthetic aperture radar (SAR) system.

(i) What is the main purpose of using dual antenna system in this design?

[3 marks]

(ii) What is the main disadvantage if we replace the dual antenna system in the figure to a single antenna system with circulator?

[3 marks]

(iii) What is the main objective of Low Noise Amplifier (LNA) in the receiver?

[2 marks]

(iv) What is the main function of the 100 MHz oscillator in this design?

[2 marks]

(v) A 500 MHz A/D is used to sample the return echo. What is the maximum allowable bandwidth for the baseband / Intermediate Frequency (IF) signal in this design?

[3 marks]

(vi) Calculate the range resolution of the SAR system in Fig. Q3.

[2 marks]

(vii) If the azimuth resolution requirement is 1 m, suggest a suitable length of the antenna to be deployed in this SAR system.

[2 marks]

Continued .....

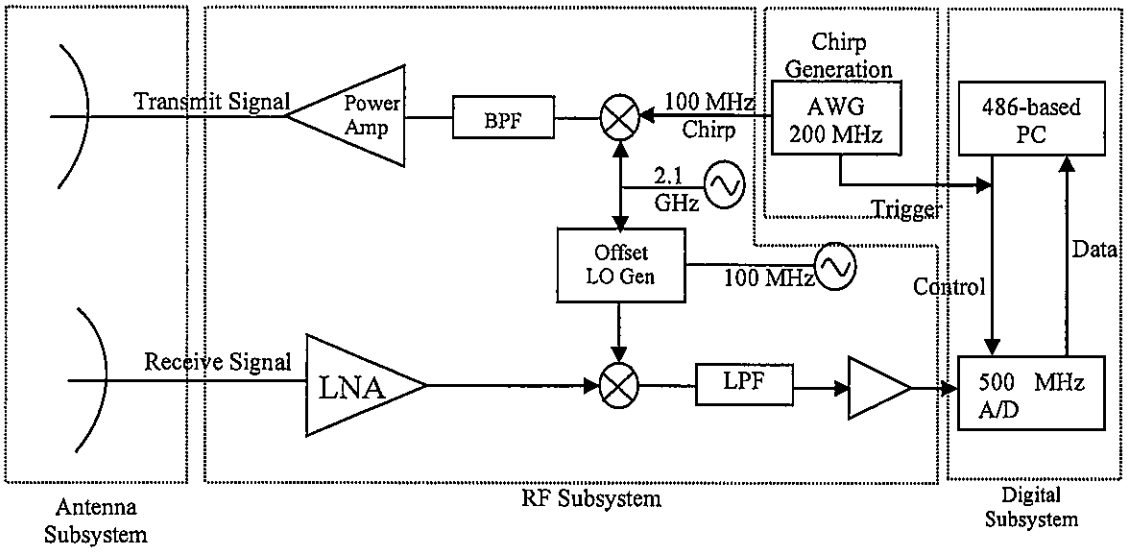

Figure Q3: Block Diagram of an Airborne SAR System

(b)

Table Q3: Specification of SAR System

System Parameters	Specifications
Mode of Operation	Stripmap
Operating Frequency	3.25 GHz (S-band)
Modulation	LFM Pulse
Bandwidth	200 MHz
Pulse Repetition Frequency	1000 Hz
Pulse Width	Variable pulse width of 1us to 10us
Polarization	VV
Antenna Gain	18 dBi
Antenna Size	1 m × 0.3 m
Look Angle	30°
Spatial Resolution	1.5 m × 1.5 m
RCS Dynamic Range 30 dB	0 dB to -30 dB
SNR	> 10 dB
Platform Height, *h*	1000 - 3000 m
Nominal Platform Speed	32 m/s
Operating Platform	UAV

An airborne synthetic aperture radar system is designed with the specifications shown in Table Q3.

(i) For the given bandwidth, calculate the best ground range resolution.

[2 marks]

(ii) Determine the best azimuth resolution able to achieve by this SAR system.

[2 marks]

Continued .....

(iii) Assuming the ground range resolution requirement is 1m, calculate the minimum bandwidth requirement of the SAR system.

[2 marks]

(iv) If the antenna azimuth beamwidth is 3°, calculate the azimuth resolution at a range of 1.5km if conventional imaging radar system (real aperture radar) is used.

[2 marks]

(v) Calculate the maximum detection range for this system.

[3 marks]

(vi) Determine the minimum transmitted power if the SNR requirement is 10dB. Assuming the noise figure of the receiver is 6dB, total system loss is 3dB and the intended detection range is 4km. [Boltzmann Constant = $1.3806488 \times 10^{-23}$ m^2 kg s^{-2} K^{-1}]

[3 marks]

(vii) Evaluate the performance of the system in terms of SNR if the transmitting power is 2kW. Assuming the noise figure of the receiver is 6dB and total system loss is 3dB.

[4 marks]

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